

The Comprehensive Aquatic Systems Model (CASM): Brief history

The CASM is a bioenergetics-based compartment model that describes the daily production of biomass (carbon) by populations of aquatic plants and animals typically for an annual cycle, although recent versions simulate up to 50 years using a daily time step. The CASM permits site-specific specification of food web structure and delineation of daily values of surface light intensity, water temperature, and nutrients (N, P, Si) that determine rates of photosynthesis of modeled plant populations. The model provides for as many as 40 populations of phytoplankton, periphyton, macrophytes, and emergent aquatic plants. Up to 40 populations of zooplankton, benthic invertebrates, decomposers, and fish can be specified. Modeled populations can be defined taxonomically or functionally. The model was designed originally to examine theoretical relationships between food web structure, nutrient cycling, and ecosystem stability (DeAngelis et al. 1989).

The CASM was modified for probabilistic ecological risk assessment as an expansion of the previous pelagic-oriented standard water column model (SWACOM) (Bartell et al. 1992). The CASM uses population-specific exposure response functions derived from laboratory toxicity data to adjust bioenergetics rates and simulate changes in population production compared to a no-exposure reference simulation. The approach assigns uncertainty to the resulting parameter adjustments and uses Monte Carlo methods to forecast the probability of different magnitudes (0-100% decrease) of impact on population production. The model permits the assessment of both direct toxic effects on producers and consumers, as well as the propagation of indirect food-web effects that can result from the differential growth characteristics and sensitivity of the modeled populations to the chemical of concern. The CASM also permits the assessment of impacts on water quality parameters included in the model (e.g., N, P, Si, dissolved oxygen, DOC, POC, water transparency).

Since its adaptation to assess ecological risk, the CASM has been applied to generic assessments for rivers, lakes and reservoirs in Canada (e.g., Bartell et al. 1999) and smaller lakes in central Florida (Bartell et al. 2000). The CASM has also been implemented for site-specific assessments of ecological risk posed by chemicals in Lakes Biwa and Suwa, Japan (Naito et al. 2003, 2002). As part of the generic assessment process, the model reference simulations have been compared to reported biomass values characteristic of the Canadian ecosystems (Bartell et al. 1999). Site-specific applications to the Japanese lakes have involved extensive calibration of the CASM to reported biomass values of the modeled populations. The model is currently being used to assess risks posed by atrazine to non-target plants in generic Midwestern streams and reservoirs, as well as agricultural canals in South Florida.

References

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